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著者	NIWA Toshifumi
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Original Paper

Information Science as a Specialty Subject for Medical Sciences II Knowledge Requirements in the Government Licensing Examination for Medical Technologist

Toshifumi NIWA

Department of Medical Technology, Health Sciences, Tohoku University Graduate School of Medicine

医療技術系専門科目としての「情報科学」II 臨床検査技師国家試験が求めるもの

丹羽俊文

東北大学大学院医学系研究科　保健学専攻

Key words : Information science in medical sciences, Government licensing examination, History of setting questions, Guideline for setting questions, Informatics needed in clinical laboratory service

In the training school for medical technologists, "Information Science" is set as a specialty subject because it is one of the fields in the government licensing examination. To reconsider the contents of the class making a connection with basic education, the knowledge required in the licensing examination was investigated. Characteristics of the questions asked in the examinations for the last 29 years were reviewed and analyzed by referring to the guideline for setting questions. As a result, the setting of questions has been reflecting the changes in the information technology and environment. It is also clarified that the every item listed in the guideline has not been asked in actual examinations. Another characteristic is that the examinee can hardly make a judgement without understanding the alphabetic abbreviation of terms.

In respect to the guideline for setting questions, particular items are frequently asked. However, some of them are questionable whether the knowledge is really needed for the operation in medical laboratory. At the moment of this investigation, the guideline was reviewed and examined for revision. Only addition of new items was proposed as required knowledge for licensing examination. However, some items should be withdrawn that the necessity has become low along with the change in information technology.

Introduction

In the Japanese government licensing examination for medical technologist, the questions were asked from various fields related to laboratory medicine, such as microbiology, physiology, serology, chemistry, pathology, as well as medical engineering. Among them, several questions are taken from information science. Therefore, "Information Science" is set as a specialty subject in the curriculum at most of the training schools for medical technologists. The contents are basic technology

supporting PC and the network in relation to the medical (or hospital) information system. The former is common matter studied in an ordinary class of information science. In recent years, the students are accustomed to PC operation and use of the network since elementary and junior high schools. Since 2003, "Information Science" is a compulsory subject in high school education. Furthermore, the information education is performed in the basic course at most universities. Therefore, it seems that the students have enough chance to acquire basic knowledge of informatics[1]. In Tohoku University, the class of information science is set as a required subject by general education course (*Zengaku-kyouiku*; Subjects Common across Campus) immediately after the entrance.

Nevertheless, the students hardly remember what they have studied in those classes after their promotion to the major course. On the other hand, they probably missed the chance to learn the document and data processing techniques employing word processor and the spreadsheet since the literacy course was discontinued according to the reconstitution of education programs[2]. Thus, the students' skill may have declined in the document and data processing necessary in the laboratory classes and others[3,4].

In the previous study, the author has investigated the rudimentary knowledge of the students and which matters they want to study in the class of "Information Science" as a specialty subject[5]. As a result, it was clarified that the students were not confident of their knowledge of informatics learnt so far in high school and general education. They wanted to confirm their understandings in the specialty class. The students should be informed in the earlier stage of their college life that questions on information science are set in the licensing examination. It was also suggested that a contrivance is needed to make students realize the necessity of informatics in the future profession[6].

Needless to say, the *raison d'être* for information science as a specialty subject is setting questions in the licensing examination. The contents of the class should cover what is asked in the examinations. In this study, the characteristics of setting questions in the examinations for the last 29 years were reviewed to clarify the knowledge required of the examinee. The characteristics were analyzed by collation with the guideline for setting questions established in 2003.

Methods

The questions relating to the information science and computer technology were reviewed through back from the 56th (in February 2010) to 23rd (in October 1982) government licensing examinations (Examination was held twice a year until 1987 and then once a year). All the questions are the multiple-choice type. Although the examinee should choose correct or wrong item out of five presented choices, it is not always one that agrees with the given condition. Thus, the examinee has to judge the correctness of every choice in most cases. We classified the questions under the subject on which the examinee requested the judgment, such as "Choose correct one about *the subject*". In case of the question just to choose correct or wrong choice extended to two or more topics, we classified it as a composite question. Then the classified questions were brought up to make a chronology by the subject.

Moreover, these questions were arranged by the item listed in the guideline for setting questions in licensing examination. The guideline classified the items at three levels. The questions were classified according to the second level items, based on the agreement with the third level items. In parallel, the matter of each choice, which does not directly concern the subject of the question, was individually classified and counted. The question in which the subject does not clearly agree with the items en-

tered in the guideline was classified as a composite question. In this case, each choice was individually arranged. Questions without clear correspondence to the third level items were separately classified, even if they correspond to the second level items. These were separately summed up before and after the guideline became effective in 2004.

Results and Discussion

History and trend in setting questions: In the gov - ernment licensing examination, 200 questions are asked in total. The number of questions in the field of "Medical Engineering" is annually around ten, including informatics. The setting of questions naturally reflects the transition of the information technology and environment by age. Until 1993, only one question related to the computer technology was asked in every examination, while no question has been set through 1985-1989. In Table 1, chronology of the subjects asked in the licensing examinations since 1990 was brought up. The automatic analyzer for the clinical examination was developed in 1953. In Japan, the automation in laboratory medicine made rapid progress in 1970's, and the first transportation system for clinical specimen is introduced in 1985. Indeed the progress in these automations could not be achieved without the support of the computer technology.

On such background, setting of questions in early 80's for medical engineering were mainly concerned with electronic circuit, signal processing and amplification, and safety handling of electric equipments. Question related to the computer appeared among those questions. In those days, the examinee was tested whether he/she could recognize a term used in the computer technology. In 1990's, computer

Table 1. Chronology of the setting questions in government licensing examinations for medical technologist since 1990.

	10	09	08	07	06	05	04	03	02	01	00	99	98	97	96	95	94	93	92	91	90
Calculation in binary notation					●									●	○						
Calculation of size of information	●				●	●		●	●	●	●	●	●				●				
Data sampling		●							●												
Signal processing					●																
Logical operation	●			●			●			●					○						●
Devices (hardware)		●	●					●	○		●	●	●	●	○	○	●		○	○	●
Software*, OS	●			●					○		●		●		●			●			
Flowchart symbols								●								●					
File format				●																	
Computer communication						●	●		●											●	
Information system, database		●	●							●					○	○			○		
Merit of introducing medical information system				●			●	●		●		●		●			●				
Transaction system						●						○	○		○			●			
Terms, abbreviations	○		○						●	○	○	●	○			●	○		○	○	○
Security	●	●	●		●	●					●										
Composed question													●		●●	●			●		

●, subject of the question ; ○, items presented as a choice
*Including programming language

network was explosively popularized : in concern with medical laboratory, hospital information system as internal and the Internet as external connection. Under the circumstances, informatics has been given an increased deal of weight, coming up to 3 questions since 1994 and 4 questions since 1998. We can understand the change in trend of setting questions coming from the domain of computer terminology, programming, network, and information security in that order.

Correspondence between questions and guideline for setting questions: The guideline for setting questions in government licensing examination for medical technologist was established in 2003, and effective from 2004[7]. It should be accepted that the guideline shows knowledge to be acquired by the examinee. In addition, we can consider the contents to be derived from setting questions in the examinations until the establishment, though there was a change by trends of the times. However, when we analyze the characteristics of the questions actually set in the examinations, the every item listed on the guideline is not asked evenly, before or after the criteria establishment (table 2). We can readily imagine that this is due to the limitation of the number of setting questions. Informatics is just a field in laboratory medicine, strictly a part of field (medical engineering) in the examination. Thus it should be almost a limit though the number of the questions had increased up to four. On the other hand, each question is composed of five choices, and thus we can put another interpretation that a composite question can cover this restriction by indirectly requesting the correction judgment of each item as the choices (table 2). Moreover, the importance of the item is reasonably different from each other.

Overall, the subjects frequently asked in questions are as follows. (1) Judgment on the type of peripherals such as input and output devices (hardware) : this subject is asked regardless of the age. (2) Calculation on size of information : this had been set in every examination until 2006. (3) Hospital information system : this is the main reason that informatics exists as a specialty subject, and has been set in every other year, since middle of the 90's, with spreading of the network system (Table 1 "Merit of introducing medical information system"). (4) Information security : this is set in every examination since 2005, while the *Act concerning Protection of Personal Information* (Personal Information Protection Law) had been in force since April, 2005 (Table 1 "Security").

It can be said that the actual examinations regularly asked these subjects, and other items listed on the guideline were covered in the form of a choice, as a part of one setting. A question composed of choices concerning two or more items (this type is not possible to be classified into one subject) has an advantage for the purpose. However, number of composed question has decreased since the guideline was enacted. This observation may suggest that Examiners Committee have made effort to set questions with consistent subject. Judging from the frequency of setting questions, we can assume that these four subjects mentioned above are essential knowledge for the examinee. In addition, operating system, programming languages and modem were frequently appeared at the level of choice. Considering the design of such questions, it seems that the examinees are demanded to know what the term means.

Another characteristic is highly frequent usage of the alphabetical abbreviations in the question sentences. Although the understanding of a term is essential in any field, if the examinee knows neither the abbreviation nor the term, even the judgement of the correction becomes difficult in the licensing examination. Therefore, it can be said that the understanding of terms is a hidden request for examinees. This may be rather prerequisite condition in the examination.

Table 2. Questions sorted according to the guideline for setting questions (Version 2003, effective since 2004). The questions were classified according to level 2 items, based on agreement with level 3 items.

Level 1	Level 2	2004-2010		1989-2004		1989-2010	
		Subject	Choice	Subject	Choice	Subject	Choice
Basic of informatics	Concept of information	1	0	0	0	1	0
	Information processing	5	0	8	4	13	4
	Level 1 total	6	0	8	4	14	4
Hardware	CPU	0	0	1	5	1	5
	Input and output devices	2	1	3	6	5	7
	Memory	0	0	3	8	3	8
	Communication device	0	1	1	5	1	6
	Level 1 total	2	2	8	24	10	26
Software	Programming language	1	0	3	4	4	4
	Operating system	1	1	1	5	2	6
	Application	0	0	0	0	0	0
	Level 1 total	2	1	4	9	6	10
Computer network	Concept of network	0	3	0	2	0	5
	Construction of network	0	0	0	0	0	0
	Procedure for communication	2	2	2	0	4	2
	Security	3	1	0	1	3	2
	Internet application	0	0	0	0	0	0
	Level 1 total	5	6	2	3	7	9
Information processing system	Centralized processing by mainframe	0	1	1	2	1	3
	Server-client system	0	1	0	0	0	1
	Level 1 total	0	2	1	2	1	4
Medical information system	Hospital information system	1	0	4	0	5	0
	Security and privacy	2	0	1	0	3	0
	System operation	1	1	1	0	2	1
	Level 1 total	4	1	6	0	10	1
Non-classified	Composite question	1	–	7	–	8	–
	Logical operation	3	0	2	2	5	2
	Calculation in binary notation	1	0	1	1	2	1
	File format	1	0	0	0	1	0
	Random access	0	0	0	2	0	2
	Batch processing	0	0	0	3	0	3
	Real-time processing	0	0	0	1	0	1
	Flowchart symbols	0	0	2	0	2	0
	Database	1	0	1	4	2	4
Grand total		26	12	42	55	68	67

According to the previous investigation, the top five subjects that students wanted to study in the class were ; calculations in binary and the hexadecimal notation (55%), job systems (50%), flowchart symbols (45%), RAM and ROM (37.5%), types and mechanisms of storage media (35%)[5]. Needless to say, students' greatest interest is on hospital information system (80%) that they had never learnt it. Here we cannot find obvious correlation between the students' requests and the frequency of setting questions. One possibility is to assume that the students answered to the questionnaire without recognizing the frequency of setting questions, though questions asked in the past licensing examinations were presented at the survey. Another possibility is that they were not interested in these topics because they are confident in such ones.

Incidentally, are the subjects asked with high frequency really essential in the clinical examination laboratories ? We naturally affirm the necessity of the knowledge on medical information system and information security. Contrarily, it is hard to imagine that the logical operation and the calculation in binary notation are directly related with the work in a clinical laboratory. Furthermore, the needs of programming or the flowchart symbols might be disappearing in laboratories even though the concept is still useful. Today, medical technologists have much less need to write a program by oneself because personal computers have come into wide use now. These subjects are certainly basics of information science, but in the present information age, they can be taken as "common knowledge". That is, the category of the basic education. Thus we should reconsider the discrimination of basic informatics[8,9] from specialized informatics. Anyway we think that the really needed in the medical laboratory are knowledge and ability to process the obtained data, and to deal with the problem with automated analyzers and information system.

With regard to setting of questions, it should be remembered that questions asked in the licensing examination are in multiple-choice type. The examination officers have to evaluate examinee's knowledge across the various fields of laboratory medicine within limited time. Therefore, a written-type test is not suitable for the purpose. Similarly, it seems to be difficult to set questions related to practical dealing with troubles, as well as data processing or academic skills, in such type of examination.

Seven licensing examinations were held under the efficacy of the guideline for setting questions established in 2003. At the moment of this investigation, the guideline was reviewed and examined for revision. According to the revising draft by advisory committee, five items are the candidates to be added including TCP/IP, system design, flowchart, ordering system, and on-line medical report. No item would be withdrawn in the field of information science[10]. However, in contrast to adding new items with development of information technology, items should be withdrawn that the necessity has decreased along with the current of the time.

Conclusion

Along with the development of information technology, the number of questions asked in the licensing examinations has increased as well as the subjects have changed. The main subjects are the hospital information system and the information security in last few years. In parallel, several items are still frequently set as questions. We can assume that these are the important subjects as knowledge required for the examinee. When the guideline for setting questions is reviewed for revision, it should be assessed from the standpoint of actual information processing in laboratory medicine. As new items should be added with the current of times, it should be equally important to withdraw items that the necessity has decreased.

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